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PETITION

To the Commissioner of Patents and Trademarks:

Your Petitioners, Charles H. Washburn, a citizen of the United States of America and a resident of Salt Lake City, County of Salt Lake, State of Utah and

Charles O. Gale, a citizen of the United States of America and a resident of Bountiful, County of Davis, State of Utah pray that Letters Patent be granted them for the new and useful

OVEN MERCURY RETORTING DEVICE

set forth in the following specification.

OVEN MERCURY RETORTING DEVICE

BACKGROUND OF THE INVENTION

1. Field:

The field of the invention is retorting devices for removing mercury from ores and other mercury bearing materials.

2. Prior Art:

The mercury-bearing material may be gold electrowinning sludge, Merrill-Crowe precipitate, smelter gas cleaning sludge, or any other material requiring removal of mercury. The material is commonly placed into an oven adapted for high temperature operation. The oven may be insulated in the interior on walls, top and door with mineral wool board or ceramic fiber cloth. The bottom may be insulated by fire brick or castable refractory material. Trays of the material are heated to volatilize the mercury, the resulting vapor then being directed through condensers, generally water cooled, to liquify the mercury vapor. The oven is subjected to vacuum to promote the volatilization of the mercury during the heating of the mercury bearing material.

Prior art retorting ovens are capable of operating temperatures of only 900-1100°F, a temperature which does not thoroughly remove the mercury. Prior art mercury retorting ovens are unable to be operated under absolute pressures lower than 500-600 Torr, further limiting mercury removal. This is largely because the oven doors warp excessively at very high temperatures, breaking the oven

vacuum seal. The oven and door frames are of common state of the art flange type components, which warp substantially at very high temperatures. Another shortcoming of prior art mercury retorting systems is that the mercury traps can only collect an unseparated mixture of the free mercury and other materials generally present in the condensate.

Therefore a need exists for an oven type retorting device which is capable of operating at much higher temperatures than presently available, in combination with lower operating pressures than are presently available, and that also incorporates an easily cleanable trap with provisions for separating the free mercury from any amalgams or sludge which may be condensed from oven gaseous effluent along with the mercury.

BRIEF SUMMARY OF THE INVENTION

With the foregoing in mind, the inventive mercury retorting device comprises an oven which can be operated at temperatures up to 1500°F, and at simultaneous absolute pressures as low as 50 Torr, said operating temperatures and pressures being achieved through unique oven and oven door constructions. The door employs a continuous, integral peripheral frame comprising hollow tubular members which provide high resistance to heat produced warping. The oven opening is similarly framed, and is also highly resistant to high temperature geometric torsional deflections. If required, cooling air may be directed through the interior of the hollow framing to further reduce distortion at high oven temperatures.

Preferably, a small, continuous flow of ambient air is utilized to purge or sweep the heavy mercury vapor from the bottom of the oven during operation.

Besides the oven, the retorting device further comprises a number of condensers, preferably water cooled, which convert the gaseous mercury effluent from the oven to liquid form, and discharges it into a tank trap to be collected beneath water along with other condensates. The liquid mercury is subsequently allowed to flow from the bottom of the downwardly sloping trap into a mercury collection pot. A vacuum pump maintains the entire system, other than the final mercury collection pot, under the aforementioned low

vacuum, including the condensers, the trap and the oven.

The ~~mercury~~ trap includes an internal baffle downwardly suspended from the top of the ~~tank~~ trap to below the water surface, to direct the gaseous effluent from the oven upwardly through the first of three condensing stages. A flow conduit then directs the effluent to pass downwardly through a second condensing stage to the space above the water but past the suspended barrier, which recovers further mercury from the oven effluent gas. Finally, the gases then flow from the trap upwardly to be subjected to the remaining condensing stage.

The trap also includes a below-water weir extending upwardly from the bottom of the trap near the lowered outlet end. This barrier prevents the outflow of any heavier metals, amalgams and sludges present in the condensate. These materials are heavier than mercury, so that it may be collected in relatively pure form in comparison to prior art traps, which do not separate these materials.

The trap has clean-out ports through which sludges and the like may be scooped from the bottom of the trap beneath the water using manual tools. This feature increases the safety of the trap by reducing any possible operator exposure to mercury vapor if present.

It is therefore the principal object of the invention to provide an oven-type mercury retorting system with improved efficiency in which the oven may operate at greatly

increased temperatures and greatly decreased pressures, the system also having a trap for condensed mercury which produces mercury of increased purity.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which represent the best modes for carrying out the invention,

FIG. 1 is a reduced scale side elevation view of the oven mercury ~~materials~~ retorting device;

FIG. 2 a partially broken side elevation view of the mercury trap of the oven mercury ~~materials~~ retorting device, drawn to a larger scale than FIG. 1.

FIG. 3 a partially broken ~~an~~ end elevation view of the trap of the oven mercury ~~materials~~ retorting device, taken along line 3-3 of FIG. 2, drawn to the same scale as FIG. 2;

FIG. 4 a plan view of the ~~retorting~~ oven of the oven mercury retorting device; drawn to a larger scale than FIG. 1,

FIG. 5 a front elevation view of the oven taken on the line 5-5 of FIG. 4, drawn to the same scale as FIG. 4;

FIG. 6 a fragmentary view ~~view of a fragment~~ of the oven of the oven mercury ~~materials~~ retorting device, taken on line 6-6 of FIG. 4 drawn to a ~~reduced scale~~ larger ~~than the~~ than scale of FIG. ~~5~~ 4, having a cutaway portion showing the welds securing the oven dome to the tubular door frame;

FIG. 7 a fragmentary view of the oven ~~an enlarged scale view of a fragment~~ of the oven ~~of the~~ mercury retorting device, showing the door retaining toggles;

~~drawn to the approximate scale of FIG. 6.~~

FIG. 8 a ~~vertical cross sectional view of~~ the oven of the ~~retorting device,~~ showing the retort material pans ~~within the oven~~, heating elements, and air inlet and gaseous effluent outlet pipes, drawn a larger scale than FIG. ~~5~~ 4;

FIG. 9 a front elevational view of the oven of the oven mercury retorting device ~~with the door thereof removed~~, showing the retort material B5 brackets, heating elements, bricks, pans and the sealing plate about the open end of the oven shell; drawn to the scale of FIG. 8,

FIG. 10 ~~another elevation view~~ B6 of the front end opening of the oven, drawn to ~~a somewhat smaller scale than FIG. 9.~~ B7 B8

FIG. 11 a ~~cross sectional view of a fragment of the oven of the retorting device~~ B9, showing the tubular frame member ~~s~~ about the open end of the oven, the seal plate, the seal member, and the seal retaining projections, drawn to a larger scale than that of FIG. ~~9~~ 10,

FIG. 12 a ~~front view of a fragment of the front end opening of the oven,~~ B10 showing the seal ~~plate and the seal,~~ B11 ~~taken along line 12-12 of FIG. 11~~, drawn to the same scale as FIG. 11;

FIG. 13 a ~~cross sectional view of a fragment of the oven of the retorting system~~ B12 showing the seal member and the B13 seal compressor of the tubular door frame ~~as well as the seal plate, and the tubular oven frame~~, drawn to a larger scale than FIG. 12;

FIG. 14 a fragmentary perspective view of ~~a fragment taken at one of the corners of the oven frame, indicating the~~ B14 mitred, continuously welded ends of the tubular frame members, drawn to a smaller scale than that of FIG. 13; and

FIG. 15 a longitudinal horizontal sectional view ~~of the oven~~ taken on the line 15-15 of FIG. 8, ~~taken along line 15-15 thereof,~~ drawn to the same scale as FIG 8, showing the sweep air inlet tube.

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DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENT

An oven mercury retorting device 10 in accordance with the invention is shown in FIG. 1. The material to be retorted is first placed in an oven 11 where it is subjected to temperatures as high as 1500° at simultaneous pressures as low as 50 Torr.

Pans ~~75~~ 37 for retorting material 83 are placed into oven 11, supported by brackets ~~76~~ 38 extending from the oven wall 68. (FIGS. 8 and 9) Forklift guides 77 enable each pan to be placed within and removed from oven 11. Horizontally positioned heating elements 78 extending between the pans ~~75~~ 37 are supported from rear wall 79 of oven shell 68 and by brackets 80 within oven 11. Cooling down air inlet piping 81 pierces the top of body shell 68. During operation, gaseous effluent outflows through passage structure 12 to condenser and mercury trap 13, urged by a small continuous flow of ambient air allowed into the oven through orifices 87 in the end leg 88 of a serpentine tube 89, preheated by flow through preceding legs 90. (FIGS. 8, 9 and 15)

An important feature of the oven assembly 11 is this sweep air tube 89, located on the bottom of oven body shell 68, laying upon insulating fire brick 92. (~~The oven~~ Oven body 68~~,~~ and door 32 also carry conventional internal insulation~~,~~ (not shown). ~~however not shown.)~~ Air entering tube 89 is warmed by conduction before emerging from spaced apart holes ~~93~~ 87, directed horizontally parallel to the fire brick 92 toward

the gaseous ~~mercury~~ outlet piping 12 leading to mercury trap ~~tank~~ 18 and condensers 14, 15 and 16. (FIG. 1) The flow of air, although small to avoid significant effect upon the internal pressure of the oven, prevents the heavy mercury vapor from pooling in the bottom of oven 11. From the oven the volatilized mercury travels through piping ~~passages~~ 12 to the condenser and mercury ~~condensing and~~ trap ~~combination~~ 13, impelled by air allowed to enter oven 11 through serpentine tube 89. (FIGS. 8, 9 and 15)

A tank trap 18 ~~The trap 13~~ is partially filled with water and is connected to water cooled condensers 14, 15 and 16. A downwardly reaching barrier 85, indicated in dashed lines in FIGS. 1 and 2, directs the gaseous effluent from the oven 11 upwardly through condenser 14, and thence by passage member 17 to condenser 15 back into trap 18 ~~the trap 13~~. The effluent then passes above the surface of the water in the trap 18 ~~tank 18 of trap 13 and~~ upwardly through condenser 16.

Condensed mercury falls by gravity from each of the condensers back into the trap 18 ~~tank 18 of the trap 13~~ to be covered by the water. The trap 18 ~~13~~, as well as the oven 11 and condensers 14, 15 and 16, are maintained at pressures as low as 50 Torr, which greatly aids in the volatization of the mercury from the retorting ~~retorted~~ material 83.

The gaseous mercury condensed and deposited into trap 13 is periodically removed through valve 20 into a mercury pot 19. To separate the mercury from other materials such

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as zinc or cadmium which may have been vaporized and carried over into ~~trap~~ tank 18, a weir plate 21 is provided ~~near the tank outlet end 22~~. (FIG. 2) Weir 21 allows the liquified mercury to flow to the outlet removal piping and valve 20, while the solid amalgams of mercury with other metals, sludge and the like are retained upstream of the weir 21 within the trap ~~tank~~ 18. A pair of bottom clean-out ports 23 and 24 permit sludge and the like which may accumulate after extended use to be removed from beneath the surface of the water, to minimize the exposure of the operator to any remaining liquid mercury. (FIGS. 2 and 3)

A drain valve 25 aids in the cleaning, often obviating the necessity of removing ~~cap plate 26. (FIG. 3)~~ B15 However, the bottom clean-out ports 23 and 24 are used infrequently. A manual dipping tool (not shown) ~~tool, not shown,~~ is used through the ~~upper ports~~ B16 for routine clean out. The bottom sludge accumulates principally in the vicinity of weir 21.

After the vapor, principally air, remaining in the trap 18 and the rest of the system including the oven 11, and the connecting passage 17, is drawn off through ~~the~~ a vacuum pump ~~20~~ 30, it is directed through a mercury vapor scrubber 31. (FIG. 1)

Unique structural framing features of the oven door 32, B17 and the oven end opening 33 enable the oven to operate at pressures down to 50 Torr with simultaneous temperatures up to 1500°F. ~~Door 32 closes one of the ends of oven 11.~~

(FIGS. 4-8) A hinge ~~Hinge~~ assembly 34 permits the opening and closing of door 32. Chairs 35 permit connection of spring loaded toggles 72. (FIG. 5 and 7) The main body shell 84 of the oven door 32 is dished outwardly providing a dome structure 44 to resist the inwardly directed unbalanced air pressure during use, while clearing oven trays 37 and tray brackets 38 interior to the oven. (FIGS. 5, 8 and 9) The outwardly dished structure is further stiffened by ribs 39 welded to dome structure external surface 40. The dome~~d~~ structure 44 contributes substantially to torsional rigidity of the door at high temperatures, but a lightweight door frame 41 provides needed extraordinary rigidity at very high temperatures. (FIGS. 4, 6, 7 and 13) Door frame ~~Frame~~ 41 comprises hollow steel tubular members 42 and 43, to which dome shell 84 is continuously welded all around its periphery. (FIG. 6 and 13) The frame members 42 and 43 are end-mitred and joined together continuously by a weld 86 at all corner junctures, in the same manner as are ~~the~~ oven framing members 62 and 63. (FIG. 14) This provides a rigid, completely integral structure, which is dimensionally stable at high temperatures. Both ~~oven frame 50~~ 318, with hollow members 62 and 63, and door frame 41, with hollow members 42 and 43, may carry spaced apart nipples 91 allowing circulation of cooling air, if needed to prevent distortion at high oven operating temperatures. (FIGS. ~~13, 6~~ 6, 7, and ~~7~~ 13)

The door is supported from the outwardly bulging dome

structure 44 by hinge assembly 34, which is attached through pivots 45 and 46 onto respective brackets 47 at the center of door 32. The opposite end of hinge assembly 34 is secured to pivots 48. Hinge attaching brackets 49 are welded to oven door opening frame 50. (FIGS. 4 and 6) Hinge assembly 34 comprises plates 60A and 60B welded together to form a frame 60A which is diagonally stiffened by the brace plate 61.

The oven opening frame 50, comprising ~~comprises~~ hollow tubular members 62 and 63 encircling the front of oven 11, with mitred ends continuously welded together at all corner junctions, ~~(FIG. 14) Frame 50~~ is stiff and torsionally stable at high temperatures being ~~and is~~ further stiffened by a seal flange 64 secured thereto by continuous welds 65 and 66 all around ~~the front opening of the~~ oven end opening 33. (FIGS. 11-~~13~~14) The inside perimeter of seal flange 64 is continuously secured to oven body shell 63 all around by weld 67.

Seal flange 64 is offset rearwardly from ~~the~~ an end 69 of oven body shell 68. A multiplicity of metallic retaining projections or seal holders 70 are spaced apart all around the seal flange 64, about oven body shell 68. Inwardly directed unbalanced pressure during oven operation tends to push a seal member 71 away from spaced apart seal holders 70, but against the protruding end 69 of oven body 68. This manner of use of the seal holders 70 eliminates expensive machining of a continuous, seal accepting groove all around the seal flange 64.

~~The seal~~ Seal member 71 comprises 3/4" x 3/4" braided

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fiberglass strands. Such fiberglass "rope" is readily available on the open market. (FIGS. 12 and 13) To assure that seal ~~rope~~ member 71 is reliably engaged when door 32 is closed and secured by toggles 72 (FIG. 7), a steel compressor 73 is provided continuously welded all around the rearwardly facing surface 74 of door frame members ~~41~~ 42 and ~~42~~ 43. 1/4" x 1/4" steel key stock may be utilized for compressor 73. (FIG. 13)

The inventive apparatus may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present apparatus is therefore to be considered illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is: